Argonne NATIONAL LABORATORY

Visualization

ALCF: Getting Started Workshop 2010

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U.S. DEPARTMENT OF ENERGY

Our Goals

- Introduce you to Eureka
- Examples of visualizations
- Visualization tools available to you
- Your large datasets
- Things to think about

- Practical tutorial
  - Getting started
  - Grokking ParaView
  - Visualization basics

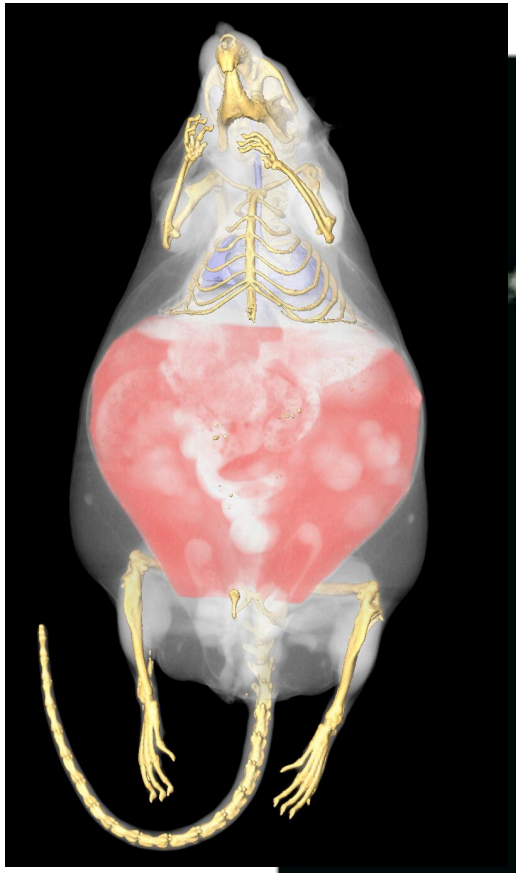
TODAY:
Kitware is here.
ParaView, VTK, ITK, TITAN, …

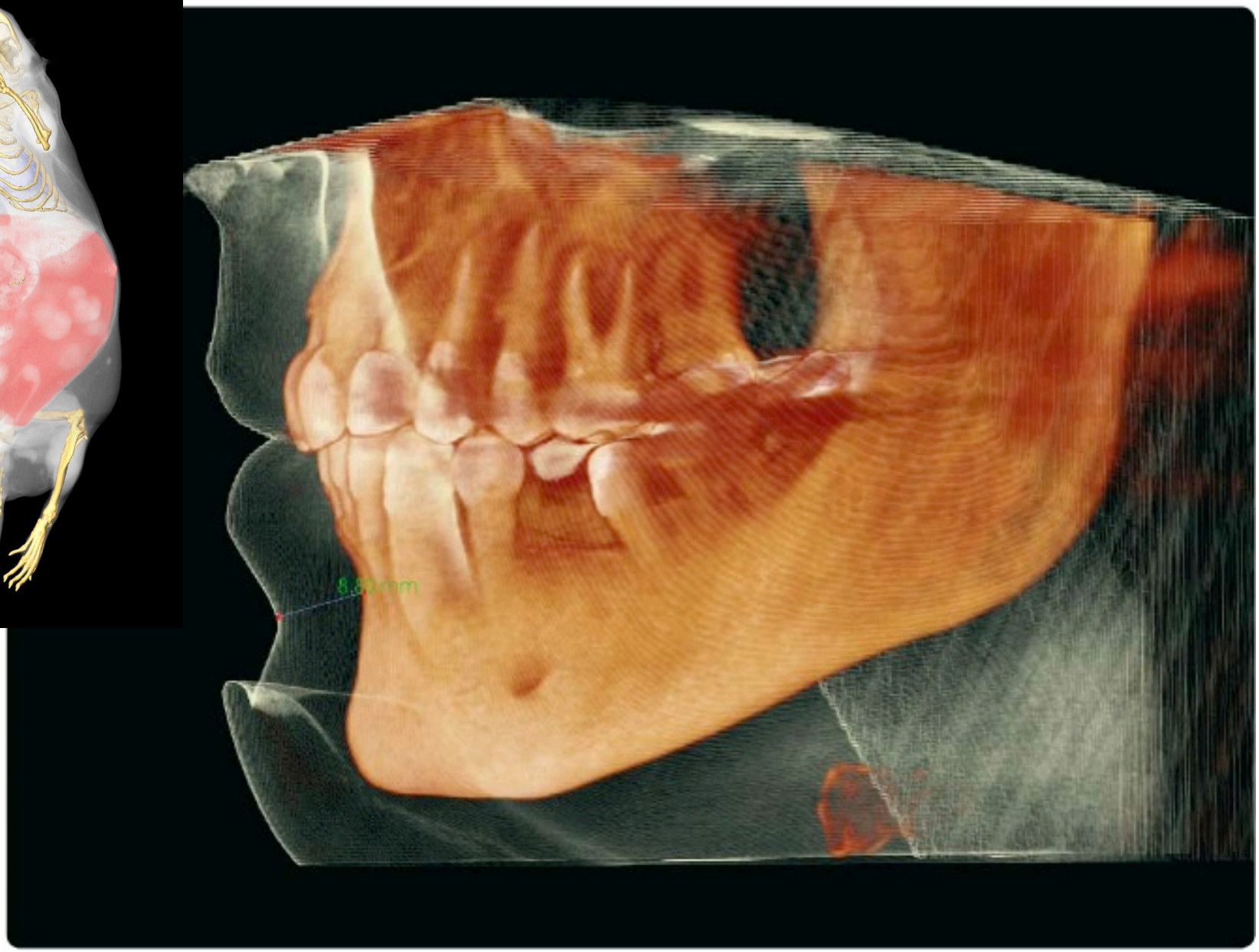
ALCF's Eureka and Gadzooks

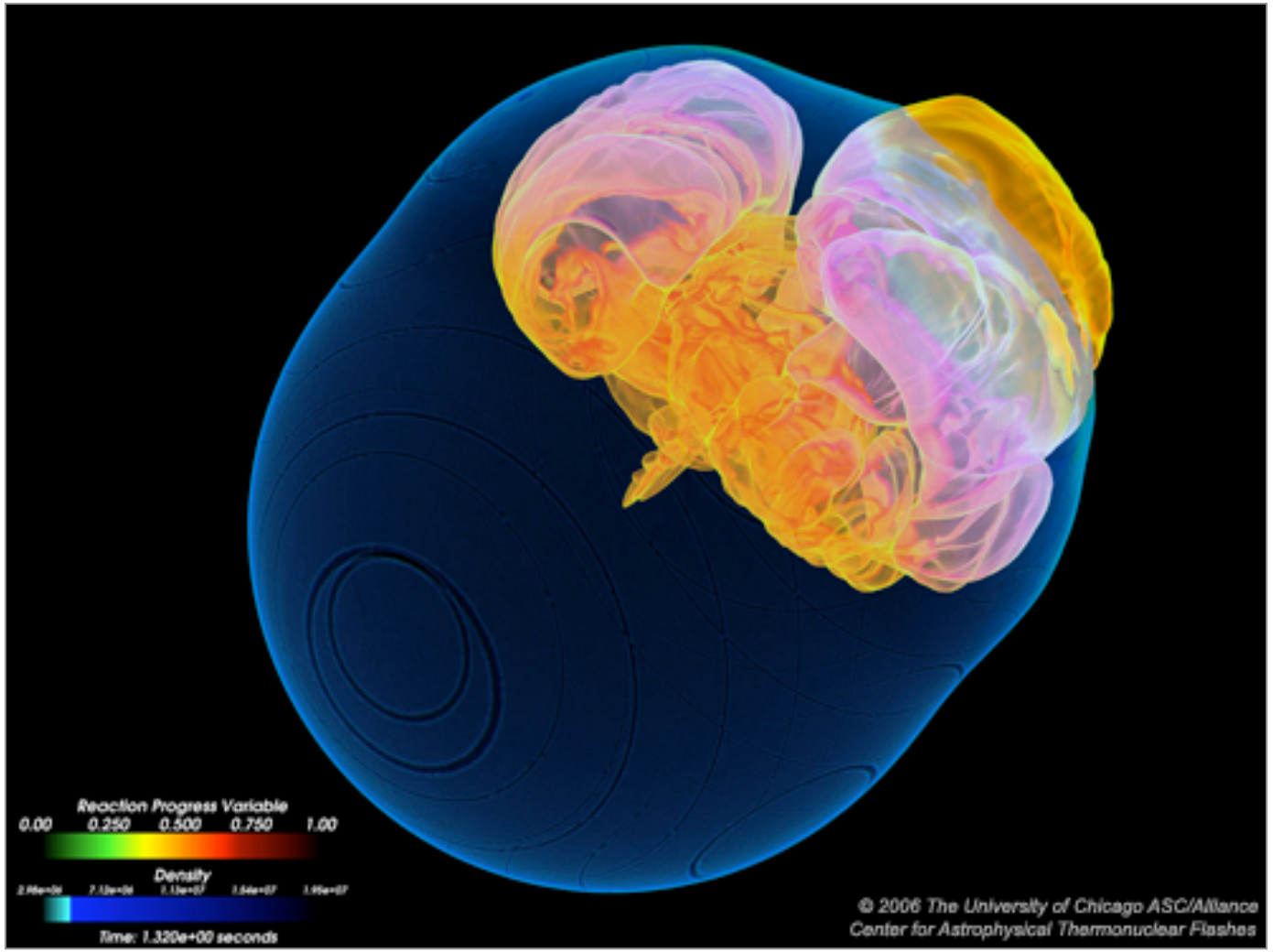
- 100 + 4 dual quad core servers
- 200 + 8 Quadro FX5600 graphics engines
- 312 Gbytes of total frame buffer RAM
- 3.2 TB of total system RAM

- Each node (server):
  - Dual quad core CPU
  - 2 GPUs
  - 1.5 GB frame buffer RAM
  - 32 GB system RAM

Slide courtesy Rob Ross, Argonne National Laboratory



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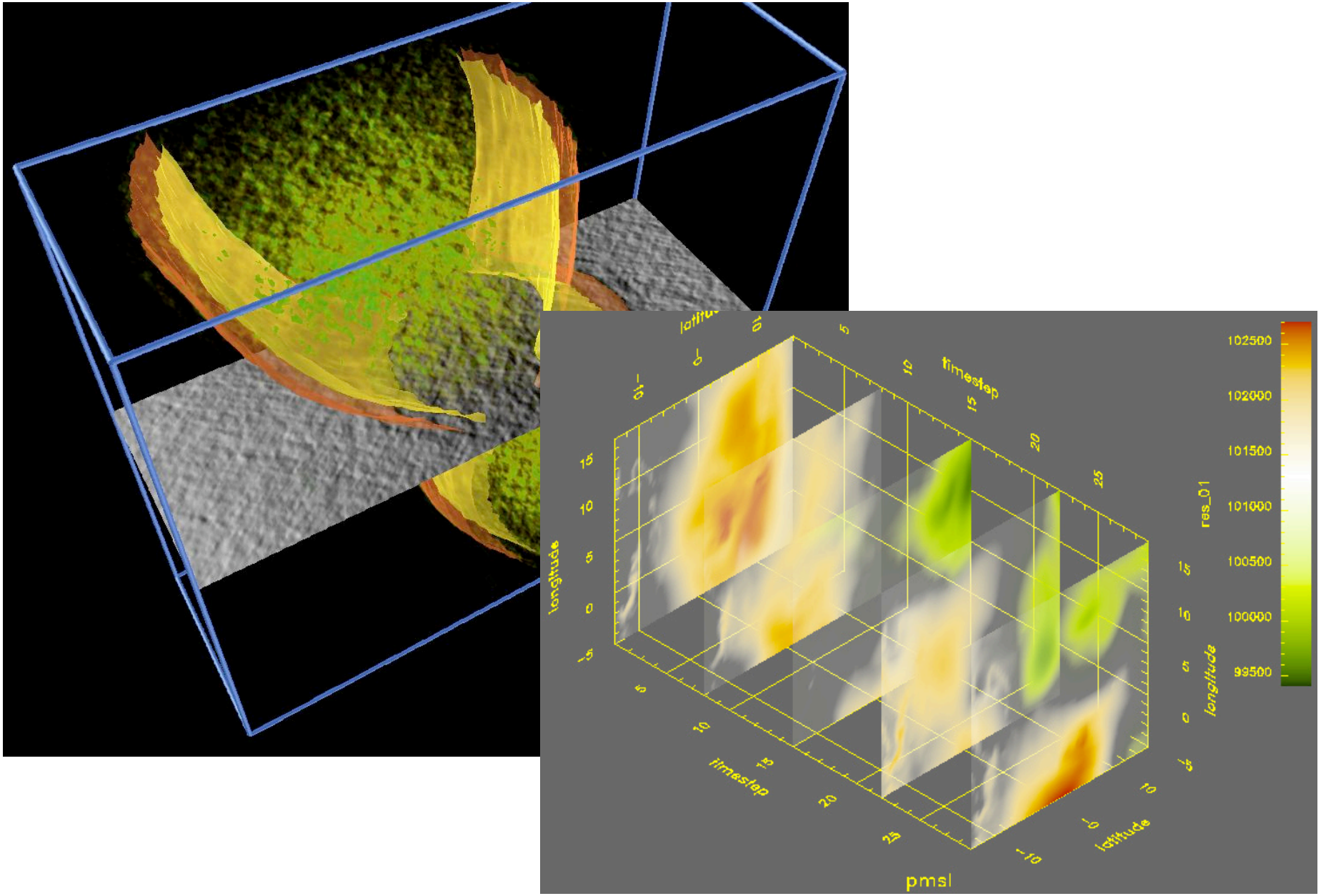
© 2006 The University of Chicago ASC/Alliance
Center for Astrophysical Thermonuclear Flashes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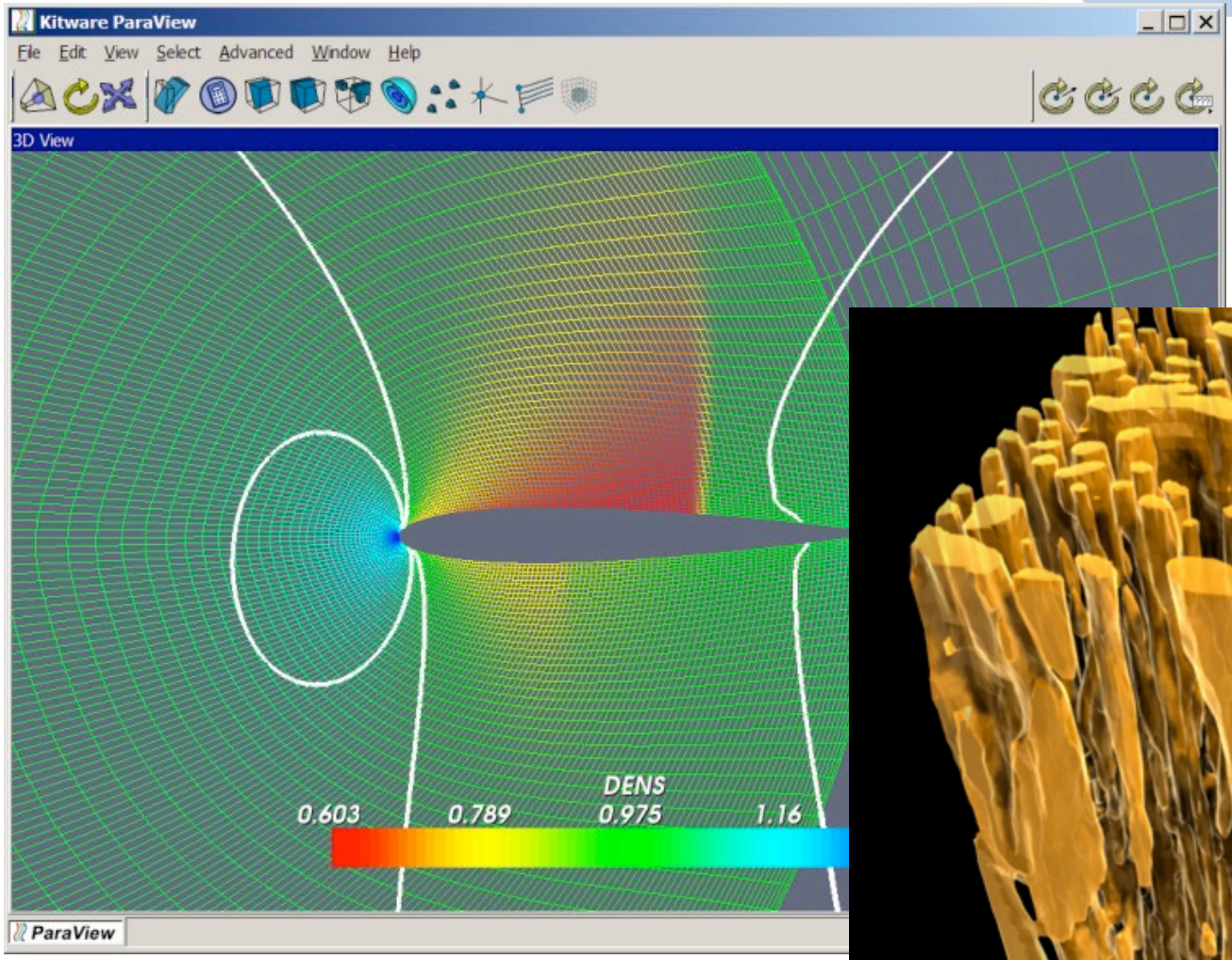
Kitware ParaView
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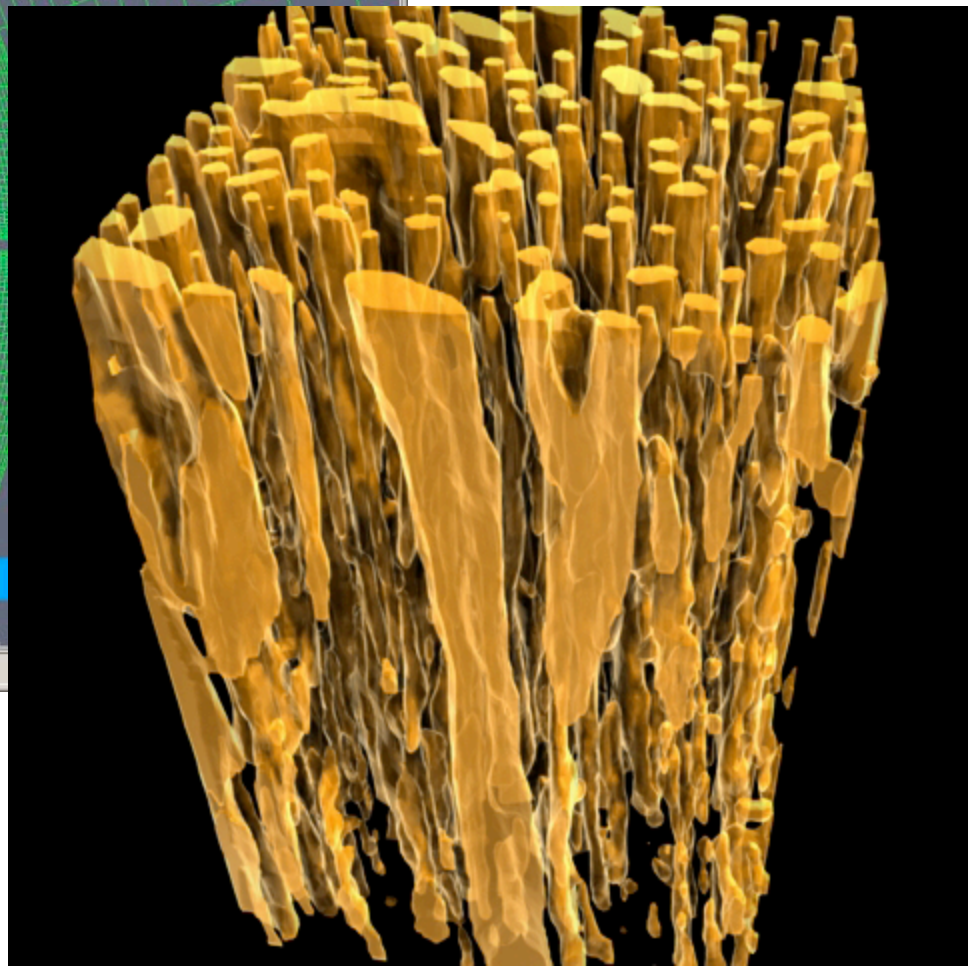
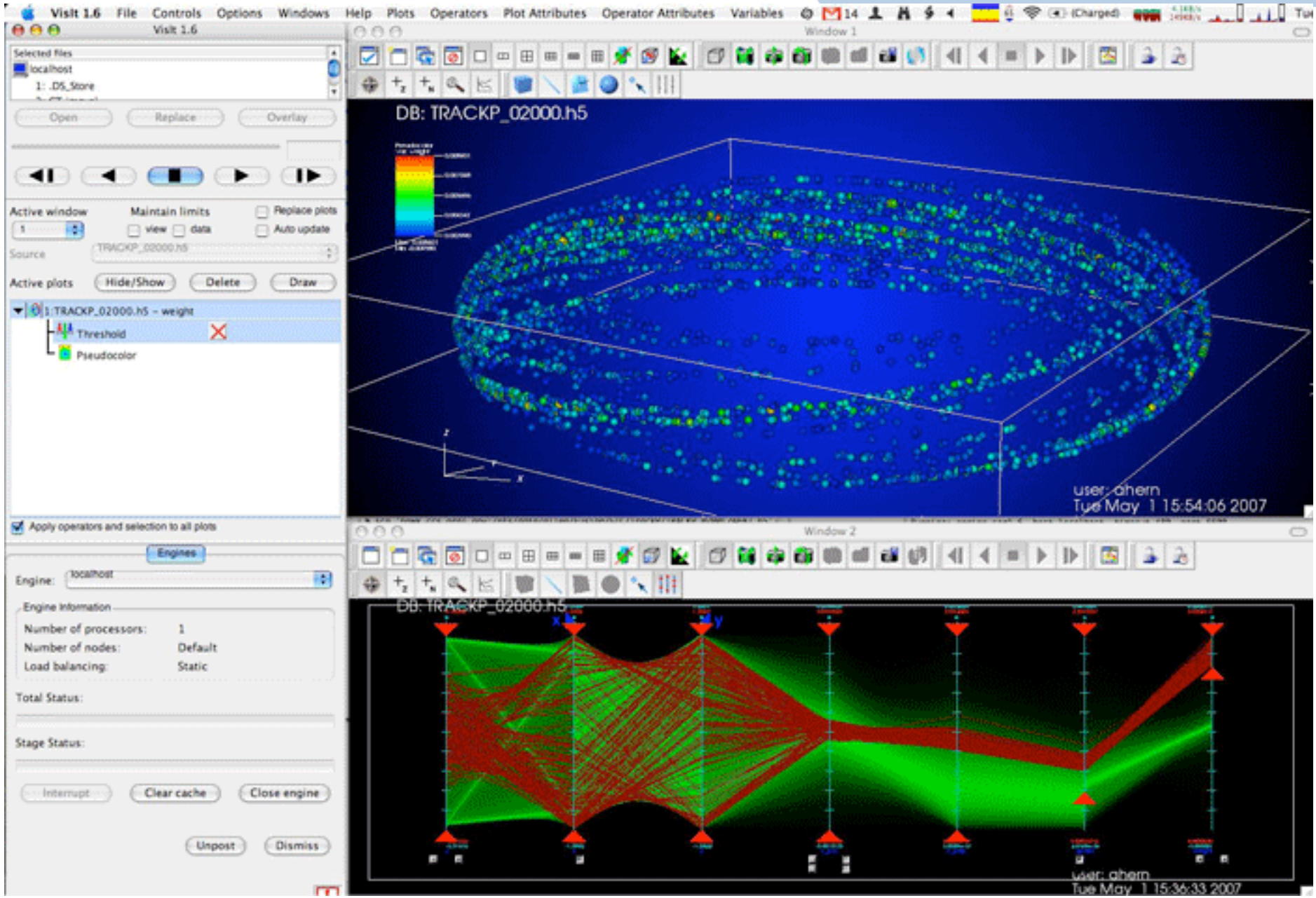
ParaView




Visit 1.6 File Controls Options Windows Help Plots Operators Plot Attributes Operator Attributes Variables
Visit 1.6
Selected files
localhost
1: .DS_Store
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view
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Auto update
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Engines
Engine:
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Engine Information
Number of processors: 1
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Window 1
DB: TRACKP_02000.h5
user: ahern
Tue May 1 15:54:06 2007
Window 2
DB: TRACKP_02000.h5
user: ahern
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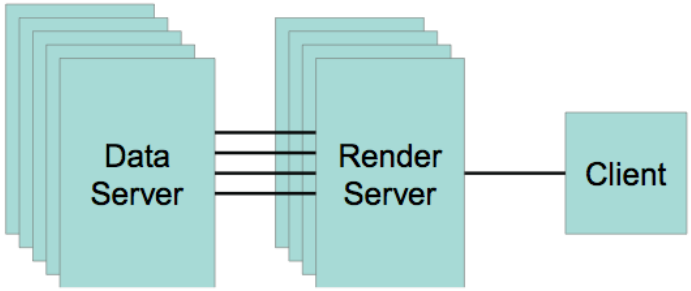
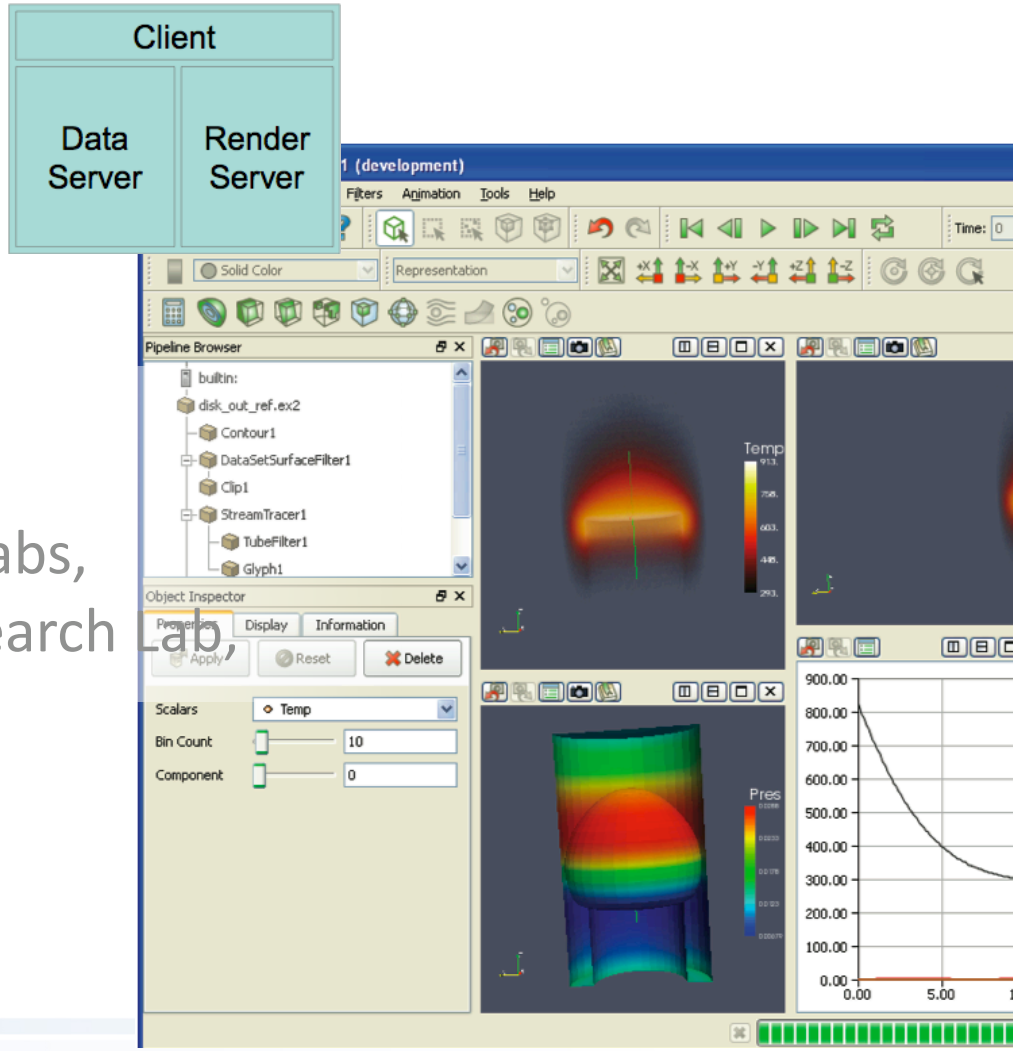
All Sorts of Tools

- Visualization Applications
  - VisIt
  - ParaView
  - EnSight
- Domain Specific
  - PyMol, RasMol
- APIs
  - VTK: visualization
  - ITK: segmentat & registration
- GPU performance
  - vl3: shader-based vol ren
  - Scout: GPGPU acceleration
- Analysis Environments
  - Matlab
  - Parallel R (ORNL)
- Utilities
  - GnuPlot
  - ImageMagick
- Visualization Workflow
  - VisTrails

ParaView Overview

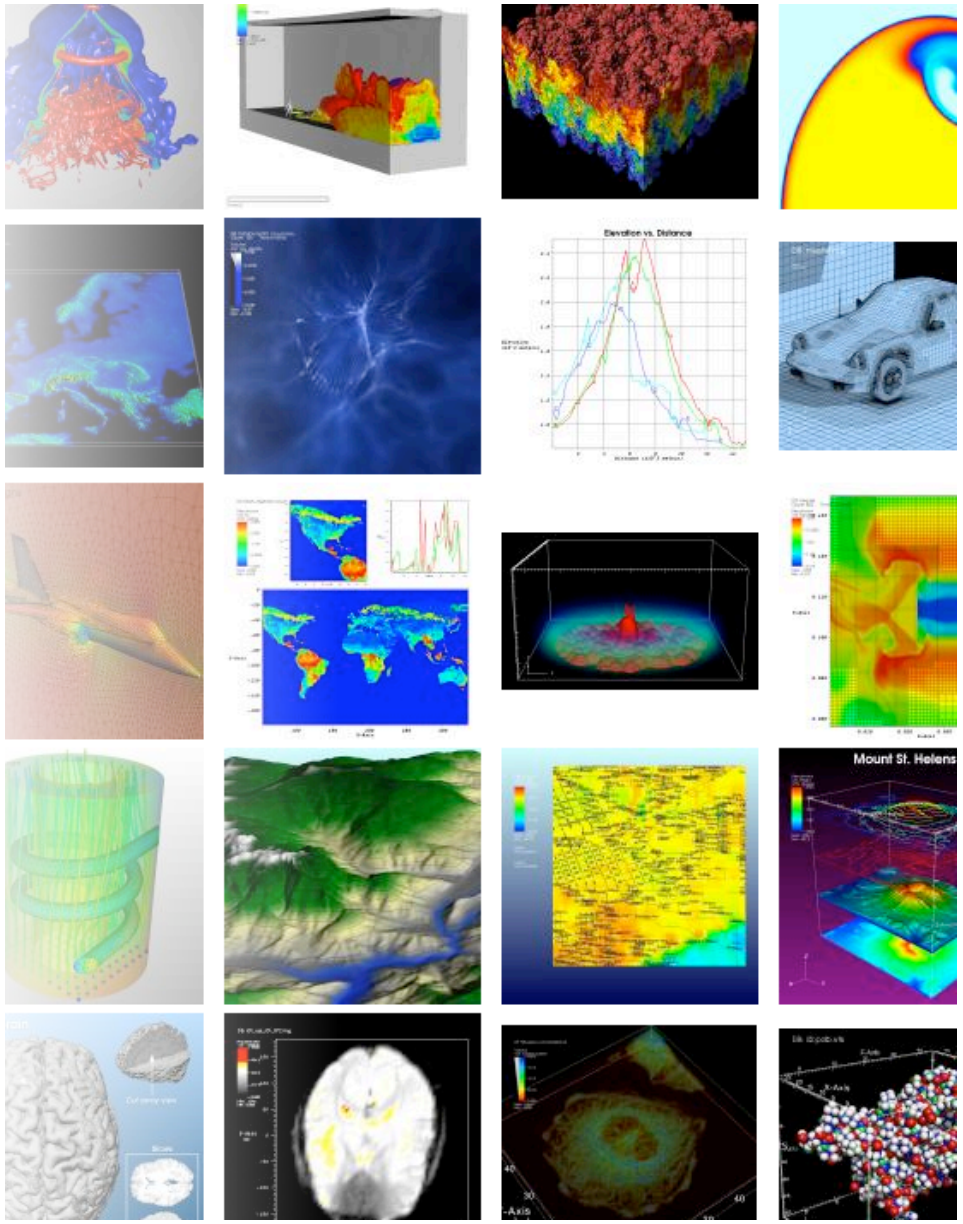
- Parallel Visualization Application
- Open source
- VTK + Tcl
- Python scripting
- Interactive and batch
- About
  - Kitware, Sandia National Labs, CSimSoft, LANL, Army Research Lab, …and community
  - http://www.paraview.org





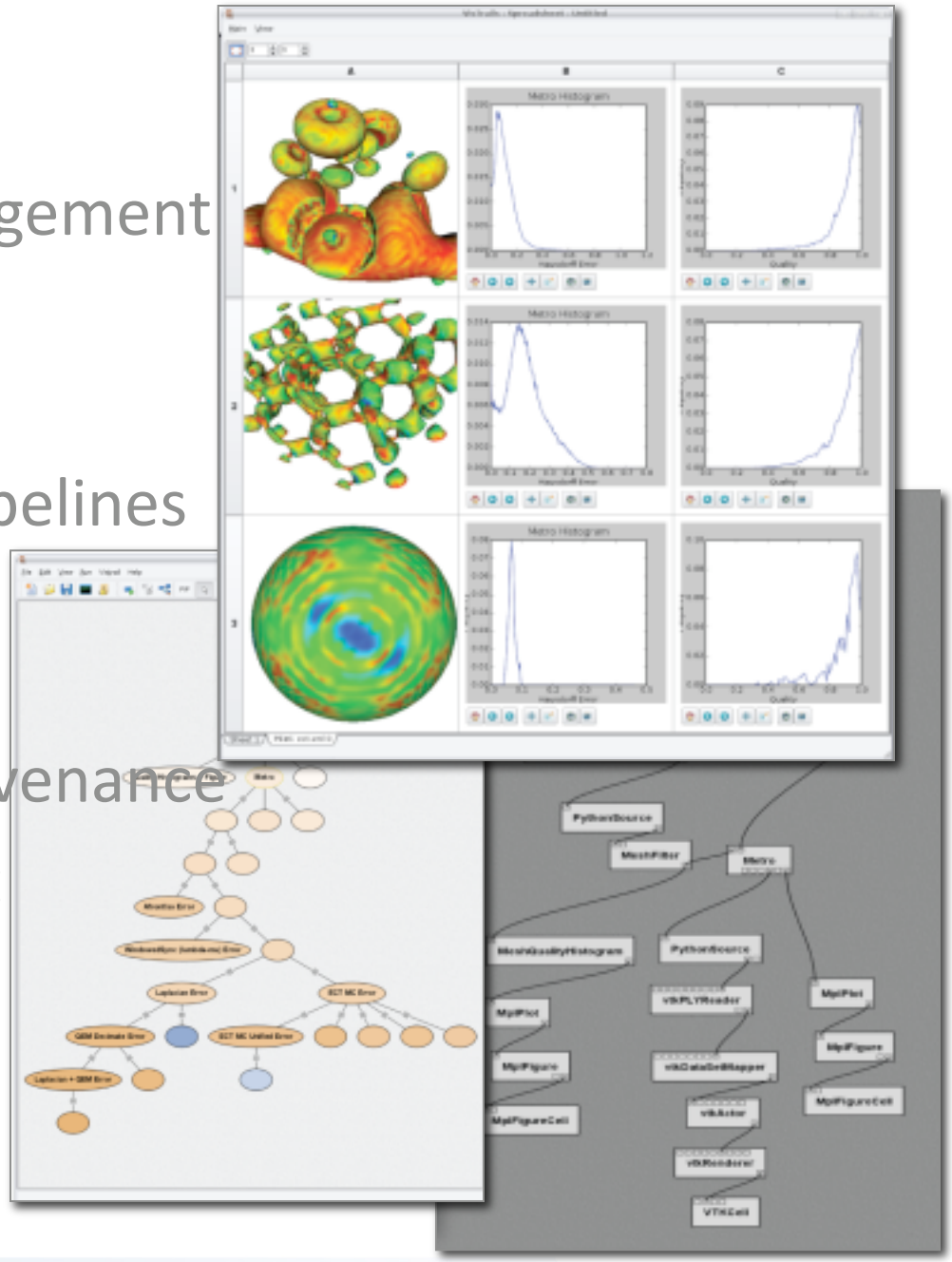
VisIt Overview

- Parallel interactive visualization application
- About
  - DOE ASCI
  - https://www.llnl.gov/visit



VisTrails

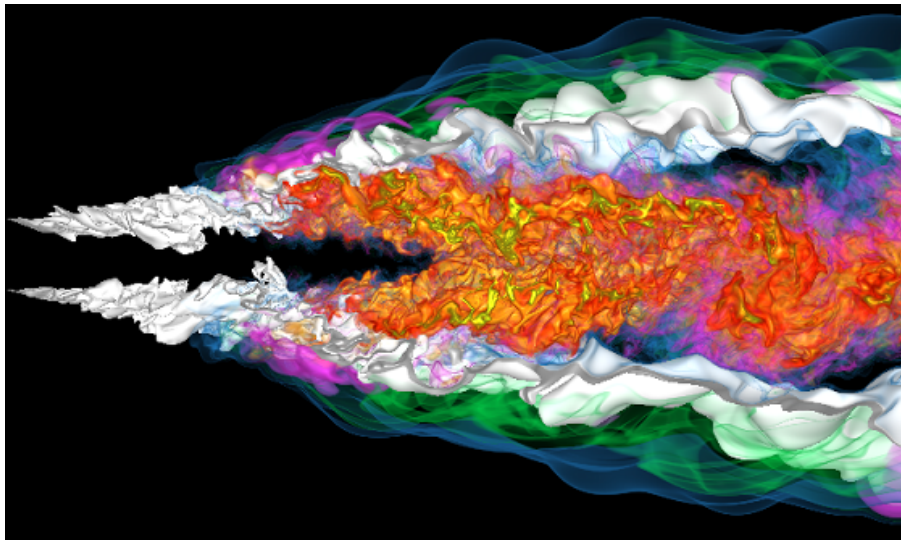
- Scientific workflow management for visual data analysis
- Construct and execute pipelines
  - Visual programming
  - VTK, ITK, and Matplotlib
- History tree captures provenance
- Visualization spreadsheet
- About
  - http://www.vistrails.org



In situ analysis and data reduction

- Incorporate analysis routines into the simulation code
  - operate on data while it is still in memory

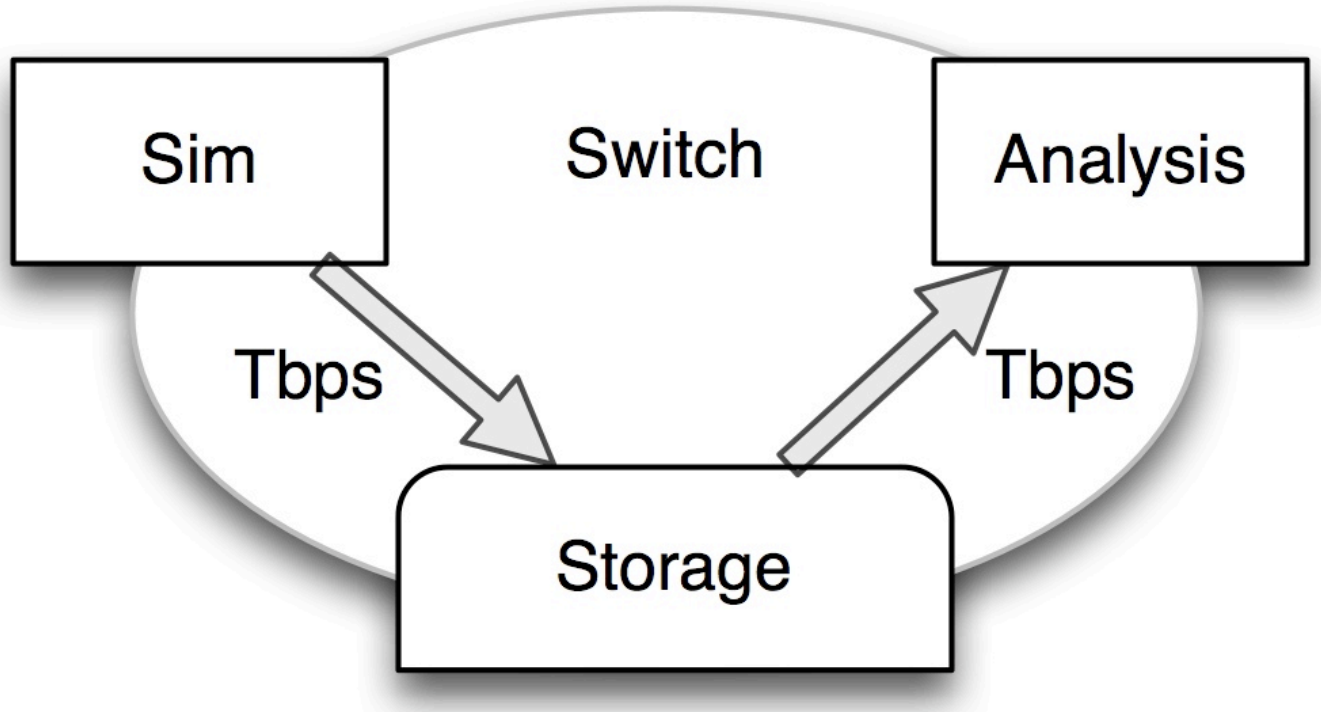
- Potential for significant reduction the I/O demands
  - application scientist identifies features of interest
  - compress data of less interest



C. Wang, H. Yu, and K.-L. Ma, “Application-driven compression for visualizing large-scale time-varying volume data”, IEEE Computer Graphics and Applications, accepted for publication.

Slide courtesy Rob Ross, Argonne National Laboratory

http://press.mcs.anl.gov/futureslab/2009/11/19/project-stargate-sc09/


Sim
Switch
Analysis
Tbps
Tbps
Storage


Sim
Gbps
Analysis
Gbps
Display

Wide Area Experiments

Simulation

- 4K uniform grid cube
- Single variable, float
- 257 GB per time step
- 577 time steps
- 150 TB total

RAW DATA

Visualization

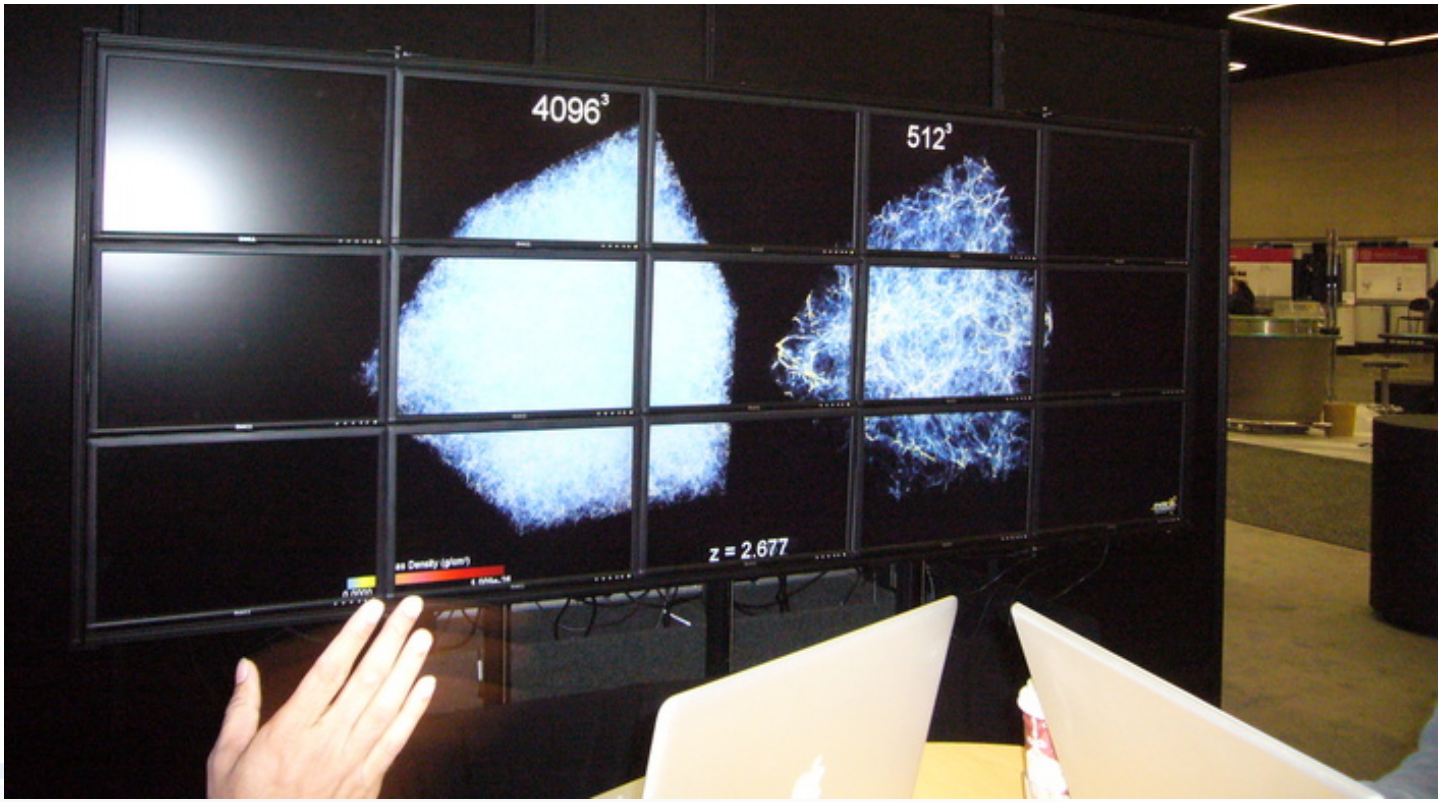
- Volume rendering
- 4K x 4K pixel

RESULTS

CONTROL

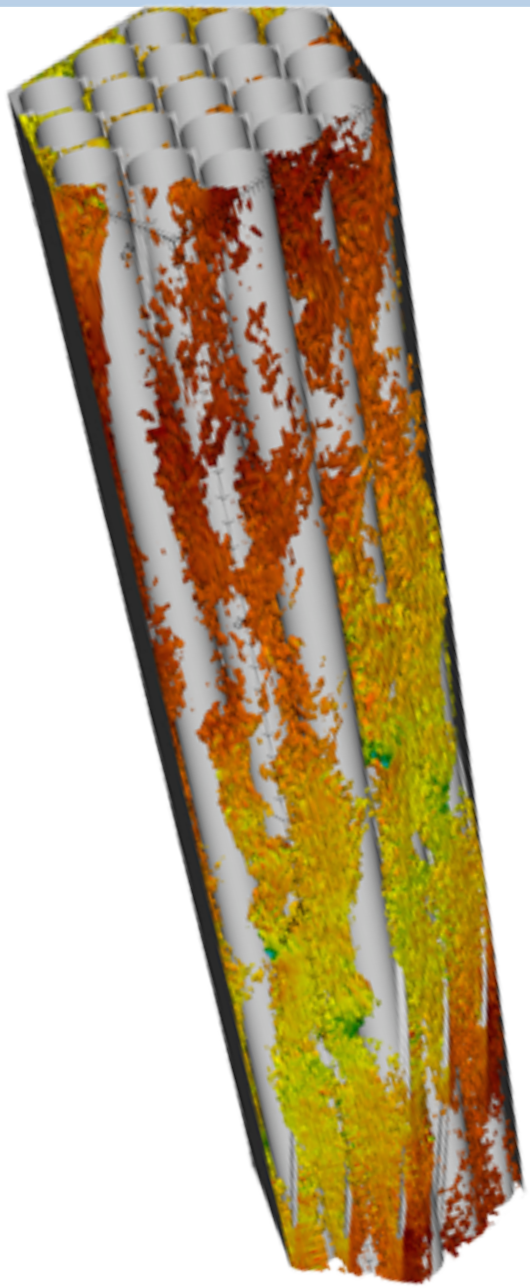
Interactive Display

- Large tiled display
- Navigation
- Manipulation



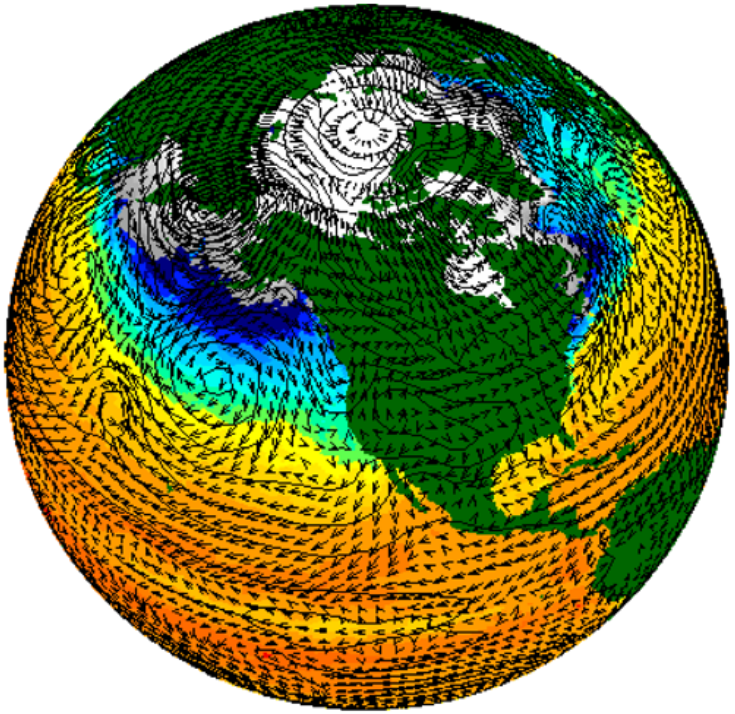
Nuclear Reactor Simulation

- Preliminary studies
  - 4.5 million elements
  - 7 variables per element
  - 20 K timesteps
  - Total data produced 2.5 TB
- Science runs
  - 3 – 4 runs with 120 million elements
  - Several runs at ½ and ¼ resolution
  - 90 K timesteps
  - Total data produced 900TB – 1.2 PB



Climate Modeling

- Preliminary studies
  - 50-100 with 3 million grid points (1 M atmosphere, 2 M ocean)
  - 100 variables per grid point (30 vectors, 70 scalars)
  - Simulating 5 - 10 years of climate
  - Total data produced 30 -124 TB

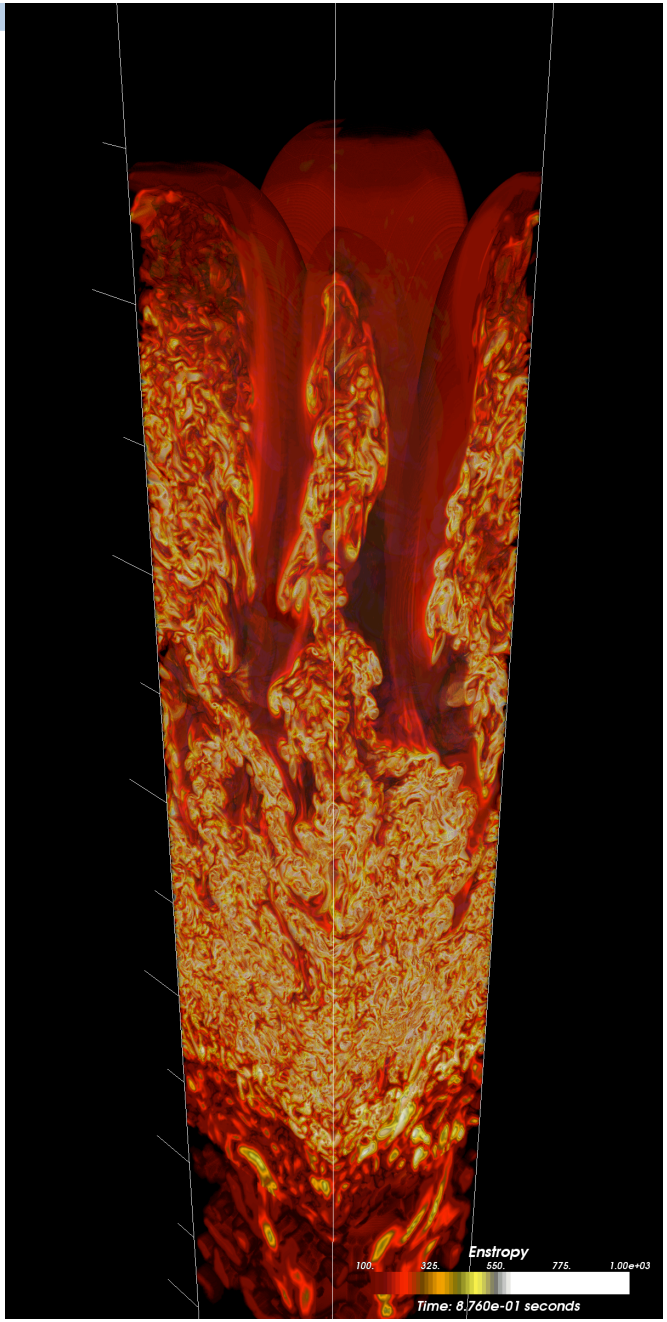


- Science runs
  - 50 runs with 6 million grid points
  - Simulating 100 years of climate
  - Total data produced 1.2 PB

Astrophysics

- Preliminary studies
  - ~80 with 67 M grid points
  - ~5 with 536 M grid points
  - 6 variables (1 vector, 3 scalars)
  - ~1800 time steps
  - Total data produced 78 TB

- Science run*
  - 10242 x 4096 grid points
  - 6 variables (1 vector, 3 scalars)
  - ~1800 time steps
  - Total data produced 48 TB
  - *3-5 times bigger allocation is needed

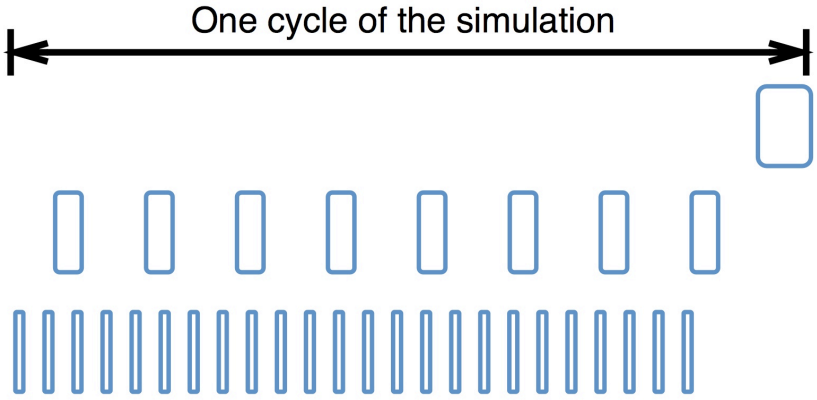


Your Goals

- What do you look to get out of analysis process?
- What analysis tools are you currently using?
  - What are the limitations?
- Do you do real-time exploration or batch processing?
  - What is the role of real-time exploration?
- Batch?
  - Percentage of your analysis time spent in either mode?
- Do you look at images, movies or graphs?
  - What is role of each (e.g. graphs for science, images publications, movies for talks)

Your Footprint

- How long do your simulations run?
  - Is the result a time series?
  - How many files does that produce?
- How much of your simulation time is I/O?
- What are your dataset sizes?
  - checkpoint files, variables, species, analysis files
- How long do you spend on analysis, what is the fraction of compute versus human?



	Files / Sim	Data Size
Checkpoint Files	100	4.2 TB
Plot Files	800	10 TB
Particle Data	5000	500 GB

Heeeeeeeere's Joe

- Practicum
  - Getting started
  - Grokking ParaView
  - Using ParaView

- Afterwards – Hands-on
  - Prepare your laptop
  - Get you connected to Eureka
  - Mess around with your data (or test data)